ICSAR R&D WORKING GROUP

SAR VISION 2010

30 April 1996

"Apply the Most Effective Systems to Save More Lives with Less Risk at Less Cost."

I. OBJECTIVE AND GOALS

A. VISION

"Apply the Most Effective Systems to Save More Lives with Less Risk at Less Cost."

B. OBJECTIVES

Foster innovation in technical, administrative and informational systems which will improve the ability of participating agencies (and associated non-governmental organizations) with search and rescue responsibilities to respond to SAR emergencies. Specific objectives are:

1. Detect distress and assist search and rescue from space.

2. Improve passive and active search capabilities to locate the distress.

3. Foster the development of low cost distress alerting and locating systems with 2-way communication devices.

4. Develop innovative methods for the extraction, evacuation, transportation and treatment of survivors.

5. Develop improvements in the management and prosecution of search and rescue.

C. GOALS

Establish and achieve the following performance standards with a 90 percent reliability factor:

1. notify the proper responder with location information within five minutes;

2. decide to launch SAR effort within 15 minutes of notification;

3. arrive on scene with appropriate resources within 1.5 hours of notification;

4. locate within 30 minutes after arrival on scene, stabilize within 50 minutes of arrival on scene, prepare for transit within 60 minutes of arrival on scene:

5. achieve a false alarm response rate of less than 10 percent;

6. reduce casualties among rescuers to zero percent; and

7. reduce cost per life saved.

D. ULTIMATE GOAL:

When possible, rescue within the golden hour. Figure 1 illustrates the three hour goal of the R&D Program and the Ultimate Target Goal of one hour.

SURVIVABILITY VS TIME
R&D GOALS AND THE TARGET
FOR RESCUE IN THE GOLDEN HOUR

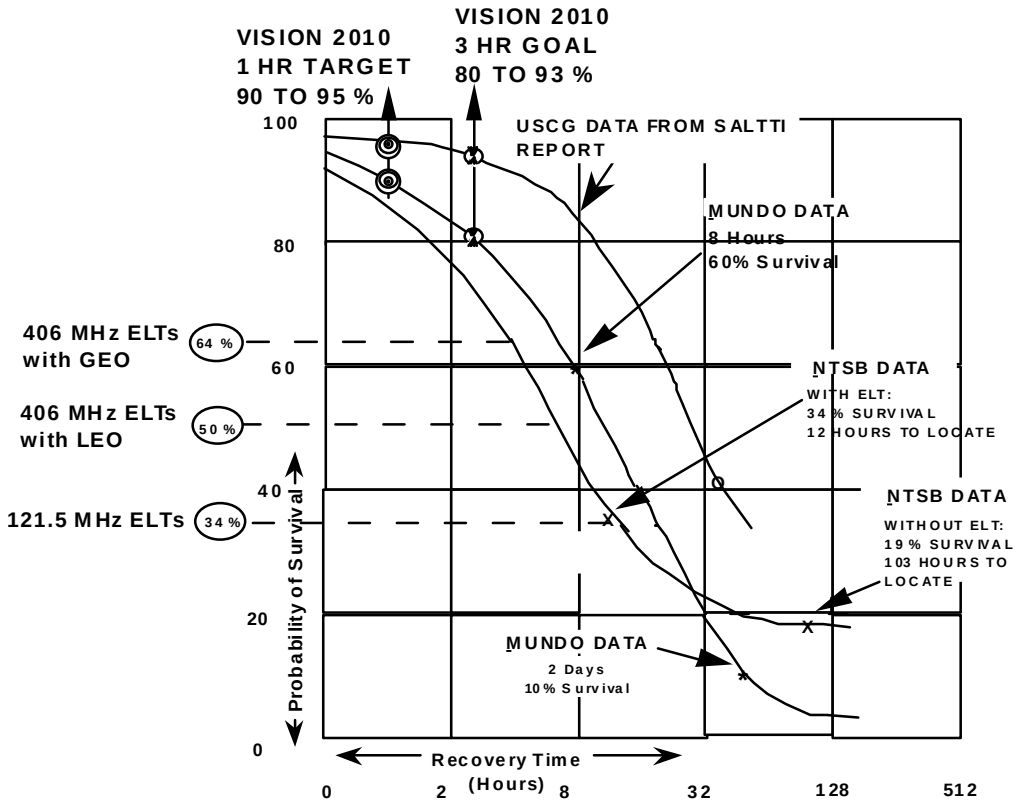


FIGURE 1

REFERENCES:

DOD & NSC data given in C. Mundo, L. Tami & G. Larson, Final Report Program Plan for Search & Rescue Electronics Alerting and Locating System, DOT-TSC-OST-73-42, February 1974.

US Coast Guard Cost Benefit Analysis, Study of Alerting and Locating Techniques and Their Impact (SALTTI), 18 September 1975, pg. 4-29, Table 4-11.

II. SAR NEEDS & ASSOCIATED TECHNOLOGY

An inventory of the needs and associated technologies was conducted by the ICSAR R&D Working Group. Search and rescue and disaster response personnel were surveyed to develop the inventory. The results of the survey were documented in a report by CSC, "R&D Working Group - Search & Rescue Needs and Technology Survey" dated July 18, 1994. A summary of the 5 greatest needs and associated technologies from the inventory is contained in Figure 2.

TOP 5 NEEDS AND TECHNOLOGIES
COMBINED RESULTS

	NEEDS	SUPPORTING TECHNOLOGIES	
1.	Communication Interoperability • Voice • Data	• SAR network control center • Frequency allocation • Low cost equipment • Seamless connectivity • Commercial comm. satellites • Response usable formats • 2-frequency radios	• Network computers w/comm sys. • Field computer capability • Multifunct. short range comm. • Uniform data/voice comm. • Seamless interface C2, logistics • Seamless connect mobilesat/SAR • Operations research
2.	Database Access by SAR and Emergency Operations Personnel	• Information resource management. • Expert/knowledge based system • Artificial intelligence • Satellite image data interpretation • Graphic/geographical interface • Real-time/near-real time database • Common to all agencies • Emergency Beacon Database	• Computer SAR planning model • Available to response teams • Data distribution prioritization • Mesh networking technologies • Track fishing vessels in AMVER • Digital computer maps • Use of National Info. Highway
3.	Passive Detection and Location of Aircraft and Marine Distresses	• Synthetic aperture radar • MASINT/satellite imagery • Signal processing all-weather sensor • Multispectral sensors trials • Laser reflected paint	• Small target detection/ID • Air/satellite remote sensing • Radar/laser reflectors • Hyperspectral sensors
4.	Timely Detection and Location of Distresses	• PLBs • Satellite-based locating • Direction find on any frequency • Commercial comm. satellites • Emergency beacon locators • Affordable equip. for locating	• Reduce/assess false alarms • GPS based navigation/ADS data • 2-Way for land alerting • Better distress alerting/warning • 406 MHz beacon w/GPS installed
5.	Urban * SAR Survivor Location and Extraction	• Small, portable, reliable equip. • Power tools for survivor extract • Reliable comm. in disaster area • Assess integrity of collapsed structure • SCBA device for voice activated microphone	• Building plans/layout • GPS, GIS mapping

* In addition to Urban SAR it was recognized that a need also exists for improvement in Survivor Location and Extraction in the Maritime, Aeronautical and Wilderness SAR areas.

FIGURE 2

III. SUMMARY OF R&D TASKS

Figure 3 shows the merging of individual agency SAR R&D efforts, along with other R&D having significant potential for SAR application, into eight Facilitating Technology areas which will be key to achieving the SAR VISION 2010. Alternately, this matrix illustrates the means being taken to insert the products of R&D in the SAR Technology Areas into improved operational benefits.

APPLICATION OF R&D TO SEARCH & RESCUE

1/31/96

FUNDING STATUS	F	F	F	F	F	F	F	F	F	F	F	F	P	P	P	F *	F *	F *	F *	F *	F *	F *	P	P	
TASK NUMBER → See Note 2	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)	
R&D EFFORTS / FACILITATING TECHNOLOGIES	COMMERCIAL MOBILE SATELLITE SERVICES	AURORA / 3WID	LASER DETECTION OF A/C & MARINE DISTRESSES	GPS LOCATION WITH GEO S/C RELAY	RADAR DETECTION OF A/C & SHIP DISTRESSES	INTEGRATED CIRCUIT DISTRESS BEACONS	KNOWLEDGE-SUPPORT SYSTEM (KSS)	DATA MARKER BUOY	USCG C4 I	REAL TIME SURFACE CURRENTS	SEARCH OBJECT LEEWAY	LASER ILLUMINATION	CSEL DEVELOPMENT	FUEL CELL DEVELOPMENT	HYDRO CUTTING DEVELOPMENT	RADAR SATELLITE (RADARSAT)	ARCTIC OCEANAGRAPHIC BUOY	SHIPBOARD UN-MANNED VEHICLE	COMPACT METEOROLIGICAL OCEANOGRAPHIC DRIFTER	LASER RADAR FOR SAR	MULTI-SPECTRAL DATA ACQ. & PROCESS.	INTEGRATE C3 IIN RCC, DND & CCG	NRL RADIANT HAIL SEARCH	TECHNOLOGY TRANSFER NIXIE TUBE X-RAY	SAR NEEDS
1. SAR C4 SYSTEM INTEGRATION	X	X							X		X											X			INTEROPERABILITY • VOICE • DATA
2. DEVELOPMENT OF SAR COMPUTER PROGRAMS							X																X		DATA BASE ACCESS
3. PASSIVE SEARCH TECHNIQUES			X		X							X				X				X					PASSIVE DETECTION & LOCATION OF A/C & MARINE DISTRESSES
4. ADVANCED SENSOR TECHNOLOGY								X		X							X		X		X				
5. BEACON DEVELOPMENT	X			X		X							X												TIMELY DETECTION & LOCATION OF A/C & MARINE DISTRESSES
6. SURVIVOR RECOVERY & EMERG. MEDICAL SERVICES														X	X			X						X	SURVIVOR LOCATION & EXTRACTION

PROGRAM DRIVERS

1. INTERNATIONAL SPACE STATION SAR OPPORTUNITIES				X	X								X			X					X				
2. PHASE OUT 121.5 MHz BEACONS & 121.5 MHz ON COSPAS-SARSAT SATELLITES	X			X		X							X												

KEY

* CANADIAN EFFORTS
F FUNDED
P PLANNED
X DENOTES APPLICABILITY OF R&D EFFORT

FIGURE 3

NOTES

1. R&D efforts are selected on the basis of their application to SAR operations.
2. See Glossary for a description of R&D efforts (by Task Number).

IV. TECHNOLOGY INSERTION SCHEDULE

Figure 4 places the technology insertion activity depicted in Figure 3 on a time scale, showing the major milestones anticipated in each of the Facilitating Technologies It also indicates, for each Facilitating Technology, the SAR applications and needs that are most benefited. Also noted are the Mission Stages that are benefited from each Facilitating Technology. Following is the definition of the SAR Mission stages taken from the National SAR Manual.

1. Awareness Stage

   - Alert
   - Overdue
   - Observer

2. Initial Action Stage

   - Incident Evaluation
   - Incident Location

3. Search Planning Stage

   - Most Probable Location Units
   - Aerospace Drift
   - Maritime Drift
   - Search Area
   - On Scene Coordination

4. Search Operations

   - Dispatch Search and Rescue
   - On Scene Search
   - Sighting andIdentification
   - SRUs Relief & Return to Base

5. Rescue Planning

   - Environmental & Survivability Issues
   - Select Rescue Method
   - Select Facilities Base

   - Plan Delivery
   - Select Rescue Unit

6. Rescue Operations

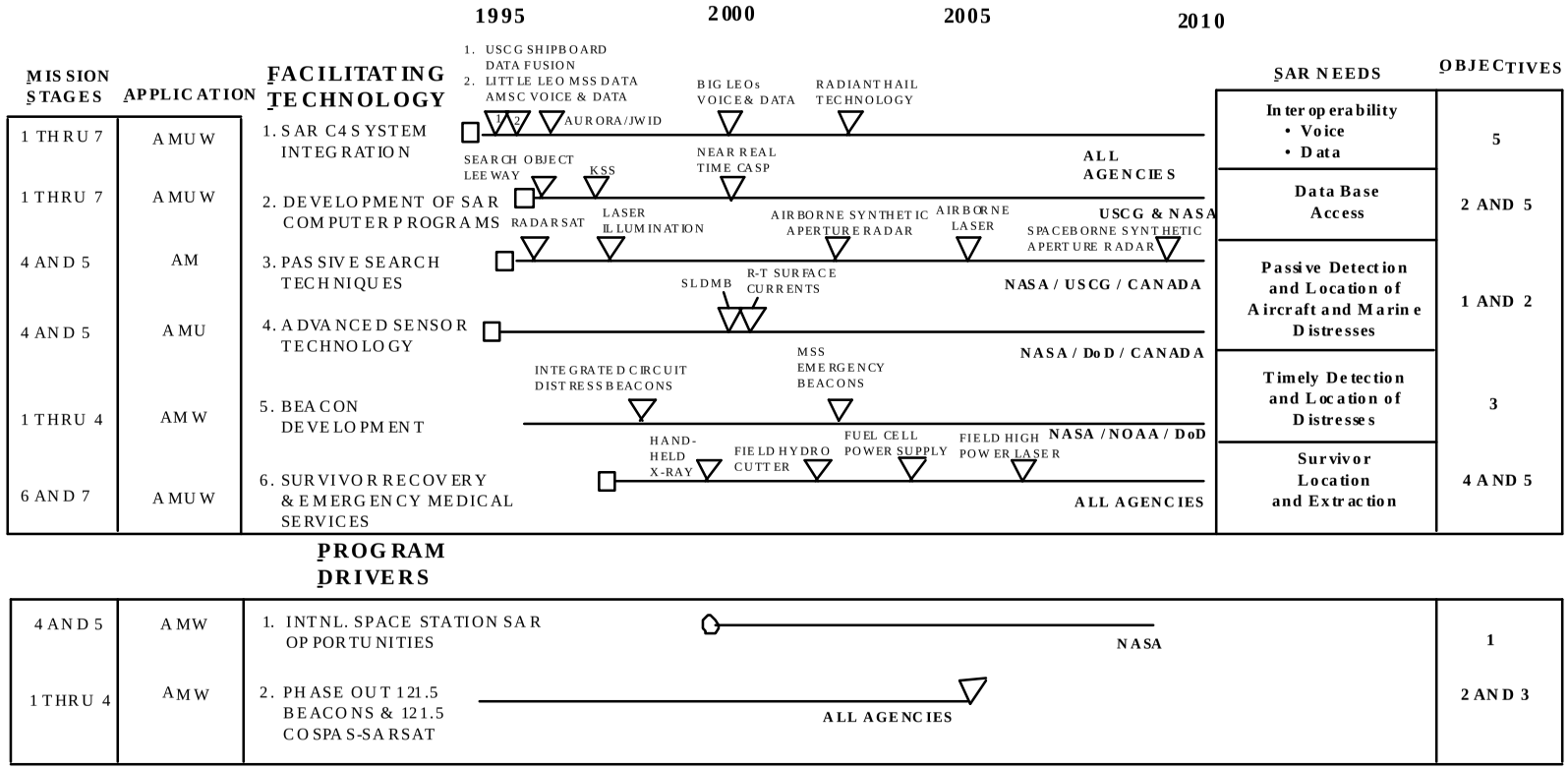
   - Dispatch & Transit
   - On Scene Rescue & Delivery
   - Rescue Unit Relief & Return to Base

7. Emergency Medical Services

   - Emergency Care
   - Survivor Debriefing
   - Evacuation & Transport

TECHNOLOGY INSERTION SCHEDULE

2/1/96



MISSION STAGES

1. AWARENESS
2. INITIAL ACTION
3. SEARCH PLANNING
4. SEARCH OPERATIONS
5. RESCUE PLANNING
6. RESCUE OPERATIONS
7. EMERGENCY MEDICAL SERVICES

APPLICATIONS

A. AERONAUTICAL
M. MARITIME
U. URBAN
W. WILDERNESS

SCHEDULE KEY

- START
- TECHNOLOGY AVAILABLE / DEPLOYMENT
- TARGET COMPLETION

OBJECTIVES

1. Detect Distress and Assist SAR from Space
2. Improve Active and Passive Search Capabilities
3. Foster Development of PLBs with 2-way Communications
4. Develop Innovative Methods for Extraction, Evacuation, Transportation and Treatment of Survivors
5. Develop Improvements in the Management and Prosecution of SAR

FIGURE 4

GLOSSARY OF TERMS
FOR R&D EFFORTS IN FIGURE 3

1. Commercial Mobile Satellite Services (MSS)

   The application of the services that will be available from commercial satellites for SAR distress alerting and locating and communications support for SAR and Distress Operations.

2. AURORA/JWID

   Demonstration program to enhance communications interoperability among federal, state, local and volunteers involved in distress operations.

3. Laser detection of aircraft and marine distresses

   Investigation into the possible use of laser illumination techniques utilizing laser reflective paint and/or material which provide a visible return from crashed aircraft and distressed marine vessels when no RF emergency beacon is radiating.

4. GPS location with GEO S/C relay

   Demonstrate the benefits of a 406 MHz ELT equipped with a GPS receiver and detected via a geostationary satellite.

5. Radar detection of aircraft and ship distresses.

   Development of an operational capability to detect crashed aircraft and marine distresses that are not radiating an RF distress signal. The system would utilize synthetic aperture radar mounted in aircraft to search for aircraft or ships in the likely areas of the distress. The synthetic aperture system provides an all weather capability including the ability to detect through foliage.

6. Integrated circuit distress beacons

   Development of 406 MHz electronics using integrated circuits employing gallium arsenide technology. This technology provides a much higher conversion efficiency, reducing battery requirements and allowing for a more compact distress unit.

7. Knowledge Support System (KSS)

   Intelligent search engine to query existing, disparate, independent data bases to obtain “just in time” information in support of real time mission execution. The KSS search engine makes use of information besides keywords to locate the subject of a search.

8. Data marker buoy

   The self locating data marker buoy (SLDMB) development is a Coast Guard effort aimed at providing critical environmental information to aid in search planning in the maritime area.

The SLDMB provides a GPS location which is transmitted to the Coast Guard utilizing the ARGOS data collection satellite system. The buoy is dropped in the most likely area for search and provides surface current drift information at regular intervals via the satellite system.

9. USCG C4I

A broad project aimed at optimizing total information flow between the Coast Guard and its customers and within the organization. Focus is impact on carrying out Coast Guard missions, not only in incident prosecution, but on ability to recognize cost benefit balance between preventive and reactive measures.

10. Real time surface winds and currents

Several projects are focused on determining real-time and near real-time surface winds and currents. These projects investigate the use of satellite borne sensors such as Advanced Very High Resolution Radiometry (AVHRR), RADARSAT and synthetic aperture radar (SAR). Future projects may include the use of Over the Horizon Radar (OTHR) as well. The Ocean Current Data Blending Project focuses on a method to combine ocean surface winds and currents which differ both spacially and temporally.

11. Search Object Leeway

Several leeway related projects examine the leeway of common search targets. New survival equipment including life rafts and survival suits exhibit leeway characteristics which differ from those which are currently documented. Additionally, the covariances or "confidence factors" for leeway values aren't known for common search objects.

12. Laser Illumination

The Laser Illumination Project will develop a near-infrared laser illuminator for use in illuminating a night vision goggle (NVG) search area. NVG's are valuable search sensors when the search area is partially illuminated, but most of their benefit is lost on a dark night (no moon or background lighting). Search objects, especially those with retro-reflective tape, are more easily detectable using laser illuminators during NVG searches.

13. CSEL Development

The Combat Survivor/Evader Locator (CSEL) system is a proposed DoD program to develop a survival radio for the armed forces that may have application to the civilian community. The system proposed would provide access worldwide with a .98 probability of success. The system design allows access by various groups without interference to the others. The survival radio would provide 2-way data messaging and user position.

14. Fuel cell development

A USCG development of fuel cells for use as a potential alternate source of propulsion power for ships. A potential also exists for the use of fuel cells for providing emergency power in urban search and rescue operations.

15. Hydro-cutting Development
The application of hydro-cutting (high pressure stream of water) to cut through various construction materials in recovery of survivors trapped in urban rescue situations.

16. Radar Satellite (RADARSAT)

A polar low earth orbiting satellite launched by Canada to monitor ice oceans and the environment. The satellite employs C-band synthetic aperture radar which can detect ships and their wake, oil slicks, ice, agriculture and forest information.

17. Arctic Oceanographic Buoy

A co-operative project between US Navy and Canadian Forces to design, build and test an air-deployable oceanographic buoy for use in Arctic conditions. The buoy was to be dropped from aircraft on a parachute, onto the ice, where it would orient itself, drill through the ice, deploy a probe and transmit data to the aircraft.

18. Shipboard Un-manned Vehicle

This project between the US Navy and Canadian Forces was to develop, test and evaluate Vertical Take-Off and Landing Unmanned Air Vehicle Systems. Payloads envisaged LLTV and FLIR.

19. Compact Meteorological Oceanographic Drifter

A joint US Navy & Canadian Forces project to design, build and test 5 unique "A" size air-deployable buoys to store and transmit marine weather data to shore sites via satellite. The US Navy plans were to deploy the system to the fleet in FY-98.

20. Laser Radar for SAR

Development of a laser-based active imaging system capable of detecting man-made objects and retro-reflective materials to ranges of several kilometers. The intent is to increase the probability of successfully locating and rescuing survivors during SAR missions in all weather conditions.

21. Multi-Spectral Data Acquisition and Processing

This project addresses the continual requirement for SAR target detection and identification in day & night, in adverse weather conditions and over cluttered terrain. Initial research concentrated on demonstrating the capabilities of optical and radar satellite imagery. Multi spectral camera systems can analyze images in 6 different spectral bands and use scenery in the search area to calibrate and train themselves to recognize different image patterns which could match a potential SAR target.

22. Integrate C3I in RCC DND & CCG

A networked automated computer system will provide RCC/MRSC controllers with a search and rescue tool to prosecute SAR cases in a multi-windowed, multi-tasked, real time environment. The system will provide accurate detection, timely assessment and efficient use

of all available resources. It will also provide an automated method for collecting data for SAR analysis and administration.

23. NRL Radiant Hail Search

The Radiant Hail Terminal is designed to be a small man-portable terminal allowing rapid deployment with access to various data bases. The terminal allows bi-directional multimedia communications across service boundaries. The terminal can disseminate any product that can be presented on a computer through a variety of RF links. Although developed for military use, the system could be applied to civilian SAR operations.

24. Technology Transfer of Nixie Tube X-Ray

A small portable x-ray developed by NASA for use in space may have application in search and rescue operations by allowing evaluation of survivors in the field prior to evacuation to a hospital.

ACRONYMS AND ABBREVIATIONS

A/C	Aircraft
ADS	Automatic Dependent Surveillance
AMSC	American Mobile Satellite Corporation
AMVER	Automated Merchant Vessel Emergency Response
ARGOS	Satellite Data Collection System
AURORA	Interoperability Demonstration Project
AVHRR	Advanced Very High Resolution Radiometry
CASP	Computer Aided Search Planning
CCG	Canadian Coast Guard
CG	Coast Guard (US)
CSEL	Combat Survivor/Evader Locator
CSC	Computer Sciences Corporation
C^2	Command and Control
C^3I	Command, Control, Communications and Intelligence
DND	Canadian Department of National Defence
DoD	Department of Defense
ELT	Emergency Locator Transmitter
FLIR	Forward Looking Infra-Red
GEO	Geostationary Earth Orbit
GIS	Geographic Information System
GPS	Global Positioning System
ICSAR	Interagency Committee for Search and Rescue
ID	Identification
JWID	Joint Warrior Interoperability Demonstration
KSS	Knowledge Support System
LEO	Low Earth Orbit
LLTV	Low Light Television
MASINT	Measurement and Signature Intelligence
MSS	Mobile Satellite Services
NASA	National Aeronautics and Space Administration
NRL	Naval Research Laboratory
NVG	Night Vision Goggle
OTHR	Over the Horizon Radar
PLB	Personal Locator Beacon
RADARSAT	Canadian Radar Satellite
R&D	Research and Development
RCC	Rescue Coordination Center
RF	Radio Frequency
RT	Real Time
SAR	Search and Rescue
S/C	Spacecraft
SCBA	Self Contained Breathing Apparatus
SLDMB	Self Locating Data Marker Buoy
SRU	Search and Rescue Unit
USCG	United States Coast Guard